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Blank, Stephan M.; Vilhelmsen, Lars

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Two new parasitoid wasp species of the Australasian genus *Orussobaius* (Hymenoptera: Orussidae)

STEPHAN M. BLANK¹ & LARS VILHELMSSEN²

¹ Senckenberg Deutsches Entomologisches Institut, Eberswalder Str. 90, 15374 Müncheberg, Germany; Stephan M. Blank [sblank@senckenberg.de] — ² Zoological Museum, Natural History Museum of Denmark, Universitetsparken 15, 2100 Copenhagen Ø, Denmark; Lars Vilhelmsen [lvilhelmsen@snm.ku.dk]

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Abstract

Two new species of the rarely collected Australasian parasitoid wasp genus *Orussobaius* Benson, 1938 are described and considered in a phylogenetic context. *Orussobaius nielspederi* Blank & Vilhelmsen, n.sp. from Yamdena, Tanimbar Islands is characterized by extensive metallic sheen on the dorsal part of the abdomen in the females. *Orussobaius bicolor* Vilhelmsen & Blank, n.sp. from Queensland, Australia has distinct contrasting body colouration, with head, thorax and abdominal tergum 1 black and the remainder of the abdomen reddish brown; the fore wings are hyaline. The two new species have been included in a data set for the rest of the Orussidae. Regardless of the analytical settings, the topology for *Orussobaius* retrieved is always (*O. caligneus* + *O. mesembrinus*) + (*O. bicolor* + (*O. minutus* + *O. wilsoni* + (*O. badius* + *O. minutissimus*) + (*O. nielspederi* + *O. paniculus*))). *O. nielspederi* is the third species of *Orussobaius* that has been recorded outside mainland Australia, where seven out of the nine known species in the genus have been found. Apparently, the genus has not been able to disperse outside the land masses connected by the Sahul Shelf as it has not been recorded outside the Australasian Region.

Key words

‘Symphyta’, parasitoid wasps, wood-living, Australasian Region, biogeography.

1. Introduction

The Orussidae is a small family of parasitoid wasps, comprising some 90 extant species worldwide (VILHELMSSEN & ZIMMERMANN 2014). In all cases where the host is known, it is a wood-living larva or pupa of a beetle (Buprestidae or Cerambycidae) or of a woodwasp (Siriidae). Orussids spend their entire pre-adult life within wood, also pupating inside it (e.g., KRAUS 1998; VILHELMSSEN 2003; BLANK et al. 2006, 2010; VILHELMSSEN et al. 2014). The genera *Guiglia* Benson, 1938, *Ophrynopus* Konow, 1897, *Orussobaius* Benson, 1938, *Orussonia* Riek, 1955, and *Orussus* Latreille, 1797 are represented in the Australasian region (VILHELMSSEN 2004). Of these

Orussobaius is the most diverse in the region, comprising nine species including the two described herein. BENSON (1938) originally described the genus for three species from Australia. Seven species were later considered in the revision by SCHMIDT & VILHELMSSEN (2002), comprising five species recorded exclusively from Australia, *O. paniculus* Schmidt & Vilhelmsen, 2002 from Papua New Guinea, and *O. wilsoni* Benson, 1938 from both Australia and Papua New Guinea.

Here we describe two new *Orussobaius* species, include them in a revised key to species of the genus, and consider these in a phylogenetic context. One of the spe-

cies described in this work was collected on Yamdena, the largest among the Tanimbar Islands, for which no sawfly species have been recorded so far. The Tanimbar Islands or Timur Laut are a group of about 65 islands which belong to the Maluku Islands in Indonesia. The group is part of an island chain extending between New Guinea and the Aru Islands in the East and Timor in the West. Besides *Orussobaius* species, two other orussid species have been recorded from New Guinea and adjacent smaller islands: *Orussus lorae* Mantero, 1899 only on New Guinea (VILHELMSSEN 2004) and *Ophrynopus maculipennis* (Smith, 1859) on Ambon, Aru and Banda islands as well (VILHELMSSEN & SMITH 2002), but neither of them from Tanimbar Islands.

2. Material and methods

2.1. Material examined

The following acronyms are used for specimen depositories: **ANIC** – CSIRO, Australian National Insect Collection Canberra, Australia; **SDEI** – Senckenberg Deutsches Entomologisches Institut, Müncheberg, Germany; **MV** – Museum Victoria, Melbourne, Australia; **OLML** – Oberösterreichisches Landesmuseum, Biologiezentrum, Linz, Austria; **QMBA** – Queensland Museum, Brisbane, Australia; **WAMP** – Western Australian Museum, Perth, Australia.

Label data of primary types are cited *verbatim*. Explanatory notes are added in square brackets. Geographical coordinates are noted in square brackets as [ca ...], if they have been identified by us.

Additional material examined: *Orussobaius badius*, holotype, ♀ (QMBA). *O. caligneus* (WAMP; we did not examine this specimen directly, but obtained images from Brian Hanich and Nikolai Tatarnic). *O. mesembrinus*, holotype, ♀, and allotype, ♂ (MV). *O. minutissimus*, holotype, ♀, and paratype, ♀ (ANIC). *O. minutus*, ♀, AUSTRALIA: Queensland, Mulgowie, 27.752°S 152.369°E, Broccoli crop, 25 July–1 August 2007, Malaise trap (bottle 11), A. Marcora leg. (QMBA); ♀, Queensland, Gatton, 27.537°S 152.340°E, Grain cropping area, 28 June–4 July 2007, Malaise trap (bottle 21), A. Marcora leg. (QMBA); ♀, Queensland, Mulgowie, 27.757°S 152.370°E, Edge riparian veg., 9–16 Jan 2008, Malaise trap (bottle 8), A. Marcora leg. (QMBA). *O. paniculus*, holotype, ♂ (ANIC). *O. wilsoni*, holotype, ♀ (MV), and 2 ♀♀ (QMBA).

Morphological terminology is based on VILHELMSSEN (2003). The terminology of HARRIS (1979) has been applied regarding surface structure except for the use of ‘pit’ instead of ‘puncture’, following SCHIFF et al. (2012). Measurements are rounded to the first decimal.

2.2. Imaging

Debris was gently removed using a penguin feather. The holotype (DEI-GISHym 18582, e.g. Fig. 2A) and two paratypes (DEI-GISHym 18585, 18586) of *O. nielspederi* were heavily covered with grease and a white substance, which was dissolved with acetone.

Figs. 2–4 and 13 were taken with a Leica DFC450 C camera attached to a Leica M405 C stereomicroscope. Lighting was either from a cold light source attached to double light guides or from a reversed LED ringlight. The specimens were illuminated indirectly by diffused light reflected from the inner surface of a styrofoam cup or a styrofoam hemisphere set up around the specimen. A gray card was usually used as background and for white balance. Composite images were created using the software CombineZP. Figs. 5–7, 9–12 and 14 were produced with a Visionary Digital imaging setup with flash lightning and P-51 Camlift Driver ver. 2.6.1 to control the camera. A cylinder of semitransparent plastic and a cone of semitransparent paper were placed around the specimen to disperse the light. Images were stored in Adobe Lightroom 2 and composite images were compiled from stacks with the software Zerene Stacker ver.1.04 by implementing the Pyramidal stacking method (PMax). Fig. 8 was produced with a Canon EOS 7D Mark II camera with a Canon MPE 65 mm 1–5 × lens mounted on a Dun Inc. Visionary Digital setup with 2 Canon Speedlite 430EX II flashes. Composite images were compiled with Helicon Focus 5.3.14. All images were adjusted with Adobe Photoshop CS6 and plates were assembled in Adobe Illustrator CS6.

Scanning electron microscopic (SEM) investigation of DEI-GISHym 18585 was performed without coating the specimen. Photos were taken with a JSM-6060LV (Jeol) microscope at 1.8–2.5 kV acceleration voltage.

2.3. Phylogenetic analyses

The two new species in the present paper were scored using the morphological character set for Orussidae initially assembled by VILHELMSSEN (2003); for the latest published version, see VILHELMSSEN et al. (2013). The matrix assembled for the present paper is available from Figshare (<http://figshare.com/articles/DataMatrixOrussidae/1599772>). We added the following characters to the data set:

170. *Distribution of hairs on the frons*: (0) more or less evenly distributed (Fig. 5B); (1) hairs in tufts arising from small pits, separated by larger pits (Figs. 2C, 2D, 13B).
171. *Mesoscutellum laterally (male)*: (0) without conspicuous groove and setation (Fig. 10A); (1) narrow groove with setae present along lateral margin (Figs. 4B, 13C).
172. *Hind tibial pegs*: (0) posterior rim smooth; (1) posterior rim distinctly crenulate (Fig. 4E). (Inapplicable when hind tibial pegs absent.)

173. *Dome-shaped sensilla on fore wing vein 2r-rs*: (0) absent; (1) one present; (2) more than one present (Fig. 4D) (ordered).

174. *Size of 2r-rs dome-shaped sensilla*: (0) none larger in diameter than 1/3 width of vein 2r-rs; (1) at least one sensillum 1/3 or more of width of vein 2r-rs in diameter (Figs. 4D, 6B) (inapplicable when dome-shaped sensilla on fore wing 2r-rs absent).

The dataset produced in Mesquite (MADDISON & MADDISON 2011) was analyzed in TNT (GOLOBOFF et al. 2000). The following characters were treated as additive: 12, 19, 24, 31, 34, 35, 46, 65, 66, 70, 75, 77, 87, 96, 103, 104, 111, 113, 114, 119, 124, 125, 126, 137, 146, 147, 149, 152, 156, 157, 159, 160, 161, 164, 167 and 173. Space for 1 000 000 trees was reserved in memory. Traditional searches in equal weights analyses and implied weights analyses with the concavity constant *k* set in turn to 1, 3, 5, 7, 9, 11, 13, 15, 20, 25 and 30 were run. Analyses were run with collapsing rules set to max. length = 0. For each weighting scheme, analyses with 10 000 replications / 100 trees saved pr. replication were conducted.

3. Taxonomy

3.1. Identification key to the *Orussobaius* species

This is a modified version of the key published in SCHMIDT & VILHELMSSEN (2002).

- 1 Mesoscutellum rounded posteriorly, interrupting mesopostnotum medially (Figs. 3B, 4B, 6A, 13C). Ocellar corona with two pairs of medially separated teeth, ventralmost pair at level with median ocellus (Figs. 2C, 5B). Ventral transverse frontal carina incomplete medially (Figs. 2C, 3A, 5B, 13B) **2 *Orussobaius***
- 1' Mesoscutellum triangular posteriorly and mesopostnotum continuous medially *and/or* ocellar corona with three or more paired teeth, ventralmost pair well below median ocellus, ventral transverse frontal carina complete **other *Orussidae***
- 2(1) Mesoscutum predominantly pale brown, distinctly paler than head and abdomen (Figs. 7C, 11C). Legs brown. Small species, 3 mm or less **3**
- 2(1)' Mesoscutum black, coloured similarly to head and abdomen (Figs. 8A, 9A, 12A, 14A), *or* with contrasting black head + thorax and predominantly reddish brown abdomen (Fig. 5A). Legs black *and/or* red. Larger species, usually more than 3 mm **4**
- 3(2) Frons with transverse strigose surface sculpture (Fig. 11B). Gena with scattered pits, interspaces variable and up to many times diameter of pit. Hind femur without shallow depressions. Male

unknown. Distribution: Australia (Queensland)

... ***O. minutissimus* Schmidt & Vilhelmsen, 2002**

3(2)' Frons with fine rugose surface sculpture (Fig. 7B). Gena evenly pitted with interspaces less than diameter of pit. Hind femur lateroventrally with group of shallow depressions. Male unknown. Distribution: Australia (Queensland)

..... ***O. badius* Schmidt & Vilhelmsen, 2002**

4(2) Head, thorax and abdominal tergum 1 black, strongly contrasting with reddish brown colour of remainder of abdomen (Fig. 5A). Fore wing in female without distinct infusate area (Fig. 6B). Distribution: Australia (Queensland)

..... ***O. bicolor* Vilhelmsen & Blank, n.sp.**

4(2)' Entire body predominantly black (Figs. 8A,B, 9A,B, 10A,B, 12A,B, 13A, 14A,B). Fore wing in female partly infusate (Figs. 2A, 8A, 9C, 14C) **5**

5(4) Malar area at most with shallow depression (cf. Figs. 5C, 8C, 9B, 10B), distinct linear groove extending ventrally from lower margin of eye absent. Hind femur slender, more than 2.5 times as long as maximal width (Figs. 9B, 10B) **6**

5(4)' Malar area with distinct linear groove extending ventrally from lower margin of eye (Figs. 2B, 13A). Hind femur swollen, about 2.0 times as long as maximal width (Figs. 4A, 12B, 14B) ... **7**

6(5) Fore- and hindwing infusate except costal cell and hyaline patch near base of pterostigma in female (Fig. 8A). Antennomere 8 of female at least 2 times as long as maximal width. Male unknown. Distribution: Australia (Western Australia)

..... ***O. caligneus* Schmidt & Vilhelmsen, 2002**

6(5)' Wings hyaline with apex of forewing and patch near pterostigma infusate in female (Fig. 9C), hyaline and only apex slightly infusate in male (Fig. 10C). Antennomere 8 of female shorter than 2 times maximal width. Distribution: Australia (New South Wales, Victoria)

..... ***O. mesembrinus* Benson, 1938**

7(5) Mesonotum with irregular pits and shining interspaces, some interspaces larger than diameter of pits (Figs. 3B, 4B, 13C). Face with tufts of pale, reclining setae (Figs. 2C–D, 13B) **8**

7(5)' Mesonotum and mesoscutellum rugose-reticulate, without distinct interspaces (Figs. 12A, 14A). Face setation not arranged in tufts (Figs. 12C, 14D) ... **9**

8(7) Antenna black, scape and pedicel dark brown (Fig. 3A). Face with golden setae (Figs. 2C–D), on ventral half reclining laterad, in dorsal half reclining dorsad, medially with almost glabrous transverse zone. Mesoscutum with dense, silvery setation particularly medially and posteriorly (Figs. 3B, 4B). Legs dark red except for black coxae, metafemur partly blackish (Figs. 3C–D, 4A). [In female, all abdominal terga with distinct

metallic blue shine (Fig. 3B).] Distribution: Indonesia (Tanimbar Islands)

..... *O. nielspederi* Blank & Vilhelmsen, n.sp.

- 8(7)' Antenna black, antennomeres 5–6 white (Fig. 13A). Face with tufts of white reclining setae directed upwards (Fig. 13B). Mesonotum glabrous (Fig. 13C). Legs black, tibiae at apex and tarsi pale. Female unknown. Distribution: Papua New Guinea (Morobe Province)

..... *O. paniculus* Schmidt & Vilhelmsen, 2002

- 9(7) Mesoscutum and mesoscutellum with fine rugose sculpture, dull (Fig. 14A). Face rugose-reticulate with small pits, with many yellow setae (Fig. 14D). Posterior margin of pronotum usually red (Fig. 14B). Male unknown. Distribution: Australia (New South Wales, Queensland, Victoria), Papua New Guinea (Central Province)

..... *O. wilsoni* Benson, 1938

- 9(7)' Mesoscutum and mesoscutellum rugose-reticulate, shining (Fig. 12A). Face rugose-reticulate with large pits, with few white setae (Fig. 12C). Pronotum entirely black (Fig. 12B). Distribution: Australia (Australian Capital Territory, New South Wales, Queensland, South Australia, Tasmania, Western Australia)

..... *O. minutus* Benson, 1938

3.2. *Orussobaius nielspederi* Blank & Vilhelmsen, n.sp.

Figs. 2–4

<http://zoobank.org/urn:lsid:zoobank.org:act:A240DC4F-E249-4EA3-9C92-DB08607F4159>

Description. *Female* (holotype; divergent character states of paratypes or the total range of variation are given in parentheses): Black. Scape, pedicel, narrow basis and tips of remaining antennomeres, almost entire antennomere 10 brown (sometimes darker), anterior and ventral side of labrum, maxillary palpomeres 4–5 pale brown (Fig. 3A). Lateral margin of pronotum brown (Fig. 3C). Tegula brown laterally and distally. Apices of coxae, trochanters, femora, tibiae, tarsi brown, middle of fore femur, latero-medial and ventral portion of hind femur, distal tarsomere of fore leg, tarsomeres 4–5 of mid and hind legs darkened (Fig. 3C,D). Fore wing hyaline proximal to pterostigma, with transverse infuscated band posterior to pterostigma, hyaline band distal of pterostigma, distal 0.15 of fore wing weakly infuscated (Fig. 2A). Pterostigma, veins C, Sc+R, basal section of 2r-rs black, point of fusion of veins M, Cu1 and cu-a dark brown, darker and obviously more densely sclerotized than immediately adjacent sections of these veins, anal veins brown, other veins pale brown to hyaline (Figs. 2A, 4D). Abdominal terga with predominantly blue metallic sheen, terga 1–2 almost completely metallic, terga 3–7 with transverse metallic stripes on posterior 0.6 of their length (Fig. 2A).

Body length 8.4 mm (6.7–8.4 mm), fore wing length 5.9 mm (4.6–5.9 mm). Antennomere 9 3.5 (3.4–3.6), antennomere 10 2.2 (2.0–2.5) times as long as wide. Distance between lateral ocelli 2.9 (2.9–3.4) times diameter of median ocellus. Ocellar corona narrow, distance between median ocellus and lateralmost coronal tooth 1.3 (1.1–1.3) times diameter of ocellus (Fig. 2C). Distance between eyes on vertex 0.7 (0.7–0.8) times as wide as distance between lateral ocelli. Frons irregularly areolate, with large pits, 40–100 µm in diameter, interspaces narrowly rounded, with weakly defined groups of small pits, 10–20 µm in diameter, between large pits. Frons and ocellar area with flattened golden setae, setation arising from dense patches in small pits, separated by larger pits (Fig. 2D); frons at mid-level with transverse, mostly glabrous zone, ca 0.7 (0.6–0.8) times as wide as frons, setae in dorsal half of frons directed dorsad, in ventral half directed laterally or ventrally. Ventral half of frons with median dorsoventral furrow (Fig. 2C; indistinct in one female). Malar area with distinct linear groove extending ventrally from lower edge of eye, continuous with furrow along posterior edge of eye (Fig. 2B). Gena with silvery setae.

Thorax except for mesoscutellum densely setose (Fig. 3B). Pronotum in dorsal view longer laterally than medially. Mesoscutum broader than long, pitted, anteromedially pits partly confluent, posterolaterally smooth interspaces in some places as wide as diameter of pits. Mesoscutellar sulcus shallow, indistinctly scrobiculate. Mesoscutellum anteriorly distinctly raised above level of axillae and mesoscutellar sulcus, pitted with narrow smooth interspaces, anteromedially not pitted, shortly setose, setation much less dense than posteriorly on mesoscutum, along anteriolateral edge without narrowly pitted and densely setose area. Mesoscutellar arm with deep pit delimited by anterior septum. Upper part of mesepisternum pitted-areolate, ventral mesepisternum imbricate between scattered pits (Fig. 3C). Hind coxa densely setose laterally. Hind femur excluding trochantellus 2.0 (2.0–2.1) times as long as wide, ventral side without longitudinal ridge, in distal 0.3 (0.3–0.5) with denticles. Hind tibia dorsally with two separate rows of pegs (Fig. 3D), lateral row with 12–13 (10–15), medial row with 11–12 (10–13) pegs, all pegs crenulate at the apex (Fig. 4E). Lateral hind tibial spur 0.5 times as long as distal width of hind tibia. Pterostigma 5.0 (4.5–5.0) times as long as wide medially, vein 2r-rs arising at 0.60 of total length of pterostigma; several small and one large dome-shaped sensilla present near apex of vein 2r-rs (Fig. 4D).

Abdominal tergum 1 scrobiculate in proximal 0.1, densely and irregularly pitted-areolate in middle section, turning from imbricate to smooth in distal 0.2, area enclosed by postspiracular carina and subspiracular carina densely setose. Smooth area laterally on tergum 2 rounded posteriorly, 2.1 (1.7–2.1) times as wide as long. Middle of tergum 5 imbricate in proximal 0.1, imbricate to pitted at 0.1–0.3, rugosely areolate at 0.3–0.9, smooth in distal 0.1. Abdominal terga 5–8 with extensive setose patches laterally (Fig. 2A). Longitudinal carina of tergum 9 absent.

Male (Fig. 4A; only differences from holotype described): Fore and mid femora completely brown. Wings completely hyaline. Pterostigma, veins C, Sc+R, basal section of 2r-rs black to brown, point of fusion of veins M, Cu1 and cu-a brown, anal veins pale brown, other veins pale brown to hyaline. Abdominal terga 1–2 with weak bronze metallic sheen, indistinct on terga 3–4, absent on distal terga.

Body length 5.2 mm (abdomen of single male slightly expanded), fore wing length 3.2 mm. Distance between lateral ocelli 2.6 times diameter of median ocellus. Ocellar corona narrow, distance between median ocellus and lateralmost coronal tooth 0.9 times diameter of ocellus. Distance between eyes on vertex 0.8 times as wide as distance between lateral ocelli.

Mesoscutellum with groove along lateral margin, groove minutely pitted, setose (Fig. 4B). Mesoscutellum with indistinct anteromedial area lacking pits. Hind coxa densely setose laterally. Hind femur excluding trochantellus 2.0 (2.0–2.1) times as long as wide, ventral side without longitudinal ridge, in distal 0.3 (0.3–0.5) with denticles. Lateral hind tibial spur 0.5 times as long as distal width of hind tibia. Metatibia dorsally with two separate rows of pegs, lateral row with 10 pegs, medial row with 9 pegs. Pterostigma 4.5 times as long as wide at middle, vein 2r-rs arising at 0.6 of total length of pterostigma.

Abdominal tergum 1 scrobiculate in proximal 0.1, densely and irregularly pitted-areolate in middle section, turning from imbricate to smooth in distal 0.2, area enclosed by postspiracular carina and subspiracular carina densely setose. Smooth area laterally on tergum 2 rounded posteriorly, 2.0 times as wide as long. Basomedial area of sternum 9 elevated above depressed lateral and distal zone, distal half concave in lateral view (Fig. 4C).

Type material. Holotype, ♀, “IDN – Tanimbar is. Yamdena isl. 20 km NE Saumlaki [7.826°S 131.423°E], 150 m Obofil lgt. 04/07”; [red:] “Holotype *Orussobaius nielspederi* det. Blank & Vilhelmsen”; “DEI-GISHym 18582”, OLML. – Paratypes: 3 ♀♀, 1 ♂ in OLML (DEI-GISHym 18583–18584, 18586–18587), 1 ♀ in SDEI (DEI-GISHym 18585), with identical collecting data.

Etymology. Named in honour of the late Niels Peder Kristensen, mentor and friend.

Remarks. *Orussobaius nielspederi* most closely resembles *O. paniculus* among the other species of the genus, sharing the presence of a lateral, setose groove on the mesoscutellum (Figs. 4B, 13C; males only, unknown for most other species) and the presence of setae on the frons in tufts (this character is most prominent in *O. paniculus*, compare Figs. 2C and 13B). Differences in the two species include *O. nielspederi* not having white markings on the male antenna and being reddish brown in a number of areas where *O. paniculus* is black: basal antennomeres, lateral margin of pronotum, and large parts of the legs. Besides, the extensive, distinct metallic blue sheen on the dorsal part of the female abdomen (Fig. 2A) distinguishes *O. nielspederi* from any other member of *Orussobaius*. The sheen may be obscured in dirty/greasy specimens

(tergum 1 in Fig. 3B), but is revealed after treatment with acetone (Fig. 2A). A much less distinct, bronze sheen is present on terga 1–2 in the single known male specimens of *O. nielspederi* and *O. paniculus*.

Among Orussidae, metallic sheen is characteristic of the genera *Chalinus* Konow, 1897 and *Mocsarya* Konow, 1897, which have strong greenish and/or bluish metallic sheen on the entire body, and in the case of *Mocsarya syriaca* Benson, 1936 reddish sheen on the abdomen (VILHELMSSEN 2001). Furthermore, some *Ophrynopus* species have a faint dark green metallic sheen on the anterior part of the head (VILHELMSSEN & SMITH 2002; VILHELMSSEN et al. 2013). The sheen in *O. nielspederi* and *O. paniculus* apparently evolved independently since none of the mentioned genera are closely related to *Orussobaius* (Fig. 1).

In most Orussidae, the infuscation of the fore wing is less prominent in males than in females (Vilhelmsen pers. obs.), but the males rarely have entirely hyaline wings when the females have infuscation. Apart from some *O. minutus*, *O. nielspederi*, and *O. wilsoni*, it is also observed in *Ophrynon* species (BLANK et al. 2010), a genus not closely related to *Orussobaius*.

3.3. *Orussobaius bicolor* Vilhelmsen & Blank, n.sp.

Figs. 5–6

<http://zoobank.org/urn:lsid:zoobank.org:act:A226339D-47C1-4587-A841-34DD7CD036F9>

Description. Female (holotype): Head, thorax and tergum 1 black, remainder of abdomen reddish brown (Fig. 5A, 6A, 6C). Mouthparts, scapus and pedicellus black/dark brown (Fig. 5B,C), remaining antennomeres reddish brown, tip of antennomere 10 dark brown (Fig. 6C). Coxae, trochanters and most of femora black/dark brown, tip of femora, tibiae and tarsi reddish brown (Fig. 5A, 6C). Fore and hind wings hyaline, without any strongly infuscate areas (Fig. 6B). Fore wing pterostigma, veins C, Sc+R, 2r and basal part of anal vein dark brown, veins Rs, veins around discal cell, M+Cu, Cu, cu-a, and distal anal veins pale brown, veins 1r-rs, 2r-m and M more or less hyaline. Hind wing Sc+R and R1, and anal veins basally brown, remaining venation pale brown to hyaline.

Body length 6.1 mm, fore wing length 3.6 mm. Antennomere 9 2.7, antennomere 10 1.5 times as long as wide. Distance between lateral ocelli 2.5 times diameter of median ocellus. Ocellar corona narrow, distance between median ocellus and lateralmost coronal tooth 0.8 times diameter of ocellus. Distance between eyes on vertex 1.5 times as wide as distance between lateral ocelli. Frons irregularly areolate (Fig. 5B), with large pits, one slender whitish seta inserted in each pit, setae curved upwards except ventrally on frons. Malar area with depression, but without narrow linear groove (Fig. 5C). Gena and occiput with large, well separated pits with one slender whitish seta each (Figs. 5C, 6A). Thorax with

scattered setae. Pronotum in dorsal view of equal length throughout. Mesoscutum and mesoscutellum areolate (Fig. 6A), mesoscutellum with deeper pits than mesoscutum. Mesoscutum broader than long. Mesoscutellar sulcus distinct, setose in middle. Mesoscutellum anteriorly distinctly raised above level of axillae and mesoscutellar sulcus, with distinct lateroposterior margin. Mesoscutellar arm with deep pit delimited by anterior septum. Mesepisternum areolate dorsally, pitted ventrally, distance between pits larger than dorsally. Median metanotal carina absent, lateral carina well developed. Hind coxa densely setose laterally. Hind femur excluding trochantellus 2.1 times as long as wide, with small denticles distally on ventral part (Fig. 6C). Hind tibia dorsally with two separate rows of approx. 10 pegs each, all pegs crenulate at the apex. Lateral hind tibial spur 0.45 times as long as distal width of hind tibia. Pterostigma 5.0 times as long as wide medially, vein 2r-rs arising at 0.5 of total length of pterostigma; several small and one large dome-shaped sensilla present near apex of vein 2r-rs (Fig. 6B).

Abdominal terga irregularly pitted-areolate except for posterior glabrous part; glabrous part becoming gradually more extensive posteriorly (Fig. 5A). Abdominal sterna predominantly pitted, with glabrous posterior part. Setation on terga sparse medially, more dense laterally, but not in distinct patches; terga 7–8 also with dense setation medially. Tergum 8 with distinct projection medially on posterior margin. Tergum 9 without longitudinal carina, shallow groove present medially.

Male: Unknown.

Type material. Holotype, ♀, “QLD:27.752°S 152.365°E, Mulgoe A. Marcora [leg.], Native remnant veg.; 21–28 Feb 2008, malaise trap (bottle 16)”; “*Orussobaius bicolor*, Vilhelmsen & Blank, 2015, female, det. L. Vilhelmsen 2015” [red] “HOLOTYPE”; (QMBA).

Etymology. The species epithet refers to the contrasting colour between the abdomen and the rest of the body.

Remarks. *O. bicolor* is easy to recognize by its body colouration and hyaline wings in the female, which are unique traits within *Orussobaius*. The combination of black head and thorax and a predominantly reddish brown abdomen in *O. bicolor* resembles a small group of *Orussus* species, including *Orussus abietinus* Scopoli, 1763, the first described species of Orussidae, but *O. bicolor* is the first species described outside *Orussus* to display this colour pattern. The occurrence of hyaline fore wings is even rarer in females of Orussidae than in males (see Remarks for *O. nielspederi*).

Apart from the colouration, *O. bicolor* also has a unique character combination within *Orussobaius*. Unlike most other members of the genus (except *O. caligneus* and *O. mesembrinus*), it does not have a narrow groove on the malar area. However, *O. bicolor* has the broad mesoscutum, the deep pit on the mesoscutellar arm, and the swollen hind femur with denticles distally on the ventral part absent from *O. caligneus* and *O. mesembrinus* but present in the remainder of *Orussobaius*.

4. Discussion

All cladistic analyses produce the same topology (Fig. 1) with regard to the placement of *Orussobaius* within the crown group of Orussidae (i.e., all extant genera and the Baltic amber fossil *Baltorussus*; see VILHELMSSEN & ZIMMERMANN 2014) and the internal phylogeny of the genus. *Orussobaius* is the sister group to all crown group orussids except *Orussonia*, *Orussella*, and *Baltorussus*. *Orussobaius* displays a number of plesiomorphic features in the head that excludes it from its sister clade: absence of a ventral coronal tooth (character 3:0 in VILHELMSSEN 2003, VILHELMSSEN et al. 2013), having an incomplete ventral transverse frontal carina (char. 19:1), and having a weakly developed subantennal groove (char. 31:0). The large clade including *Orussobaius* is supported by the presence of a short, subcylindrical scape (char. 34:0), the presence of distinctly angled medioventral margins on the hindcoxa (char. 96:2), and the presence of crenulations on the dorsal pegs of the hind tibia (char. 172:2; not *Orussobaius mesembrinus*, which has weakly developed dorsal pegs, see below; not checked for *O. caligneus*).

The presence of crenulations (Fig. 4E) is correlated with the presence of the dorsal pegs (char. 103:1&2), which are also found in *Baltorussus*, but without the crenulations. The crenulations are secondarily lost in a few *Chalinus* and *Orussus* species. Some species have similar pegs with crenulations also on the mid tibia, but they are always most prominent on the hind tibia, with up to two parallel rows of pegs situated dorsally along the length of the tibia. In this position, the pegs will project above the surface of the body when the wasp is encased in its pupal chamber inside wood with the hind leg folded up as in Figs. 3D and 4A; the wings will be folded away one above the other dorsal to the abdomen. It is likely that the pegs and crenulations will help the wasp brace itself and push against the walls of the pupal chamber when chewing the escape tunnel. Indeed, the short and broad hind femur (Fig. 4A; see also figs. 1 & 7 in SCHMIDT & VILHELMSSEN 2002) present in many orussids, including most *Orussobaius* species, would indicate the presence of substantial musculature useful in this context. It is possible that the hind tibial pegs are another example of adaptation to facilitate escaping from the wood displayed by many wood-living Hymenoptera (see VILHELMSSEN & TURRISI 2011).

The monophyly of *Orussobaius* is supported by having the posterior margin of the mesonotum interrupted medially by the mesoscutellum (char. 82:1), the presence of well-developed post- and subspiracular carinae on abdominal tergum 1 (chars 137:2 & 138:1), and having a swollen terminal structure (tergum 10 and cercus) in the female abdomen (char. 158:2). The presence of a comparatively large dome-shaped sensillum in the distal part of the fore wing vein 2r-rs (char. 174:1; Fig. 4D, 6B) is an additional potential autapomorphy, being present in all members of *Orussobaius* examined so far and not observed in any other orussids.

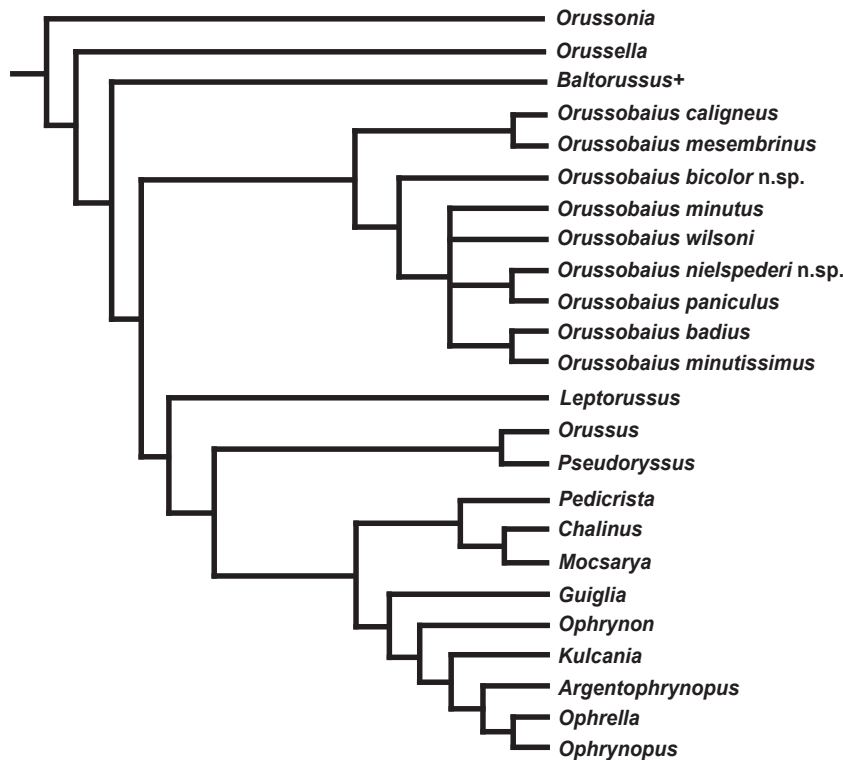


Fig. 1. Consensus tree of 18 trees of best fit 43.34643 produced by implied weights analysis with $k = 9$. Outgroup taxa and stem group orussids have been removed and all genera except *Orussobaius* have been collapsed to single terminals.

O. nielspederi is always placed as the sister to *O. paniculus* as would be expected from the similarities between the two species. The characters supporting this relationship are: having the hind margin of the pronotum glabrous (char. 50:1), the presence of tufts of hairs on the frons (char. 170:1) and the presence of a hairy groove laterally on the mesoscutellum in the male (char. 171:1; this character still needs to be checked from the species for which males are unknown, i.e., five out of nine). Within *Orussobaius*, *O. nielspederi* is part of a larger clade (all species except *O. caligneus*, *O. mesembrinus*, and *O. bicolor*) defined by the presence of a malar groove (char. 30:1) and the fore wing Rs vein being coloured only for a short distance (char. 117:1). The sister to this clade is always *O. bicolor*, the combined clade having the mesoscutum broader than long (char. 64:1) and bearing denticles ventrally on the hind femur (char. 97:1).

Orussobaius nielspederi is the first orussid recorded from the Tanimbar Islands. The genus is otherwise restricted to Australia and New Guinea. These two landmasses have been repeatedly connected across the Sahul Shelf during Pleistocene sea level regressions. Tanimbar Islands lie just off the Sahul Shelf, so dispersal of *Orussobaius* when sea level was low is not difficult to imagine. The genus is an early lineage of Orussidae that has probably been isolated in Australia since it separated from Gondwana (VILHELMSSEN 2004). It apparently has not managed to disperse into the Indomalayan Region. In contrast, the more widespread genera *Ophrynopus* and *Orussus* have reached New Guinea, presumably from Southeast Asia, since neither genus has been recorded from mainland Australia.

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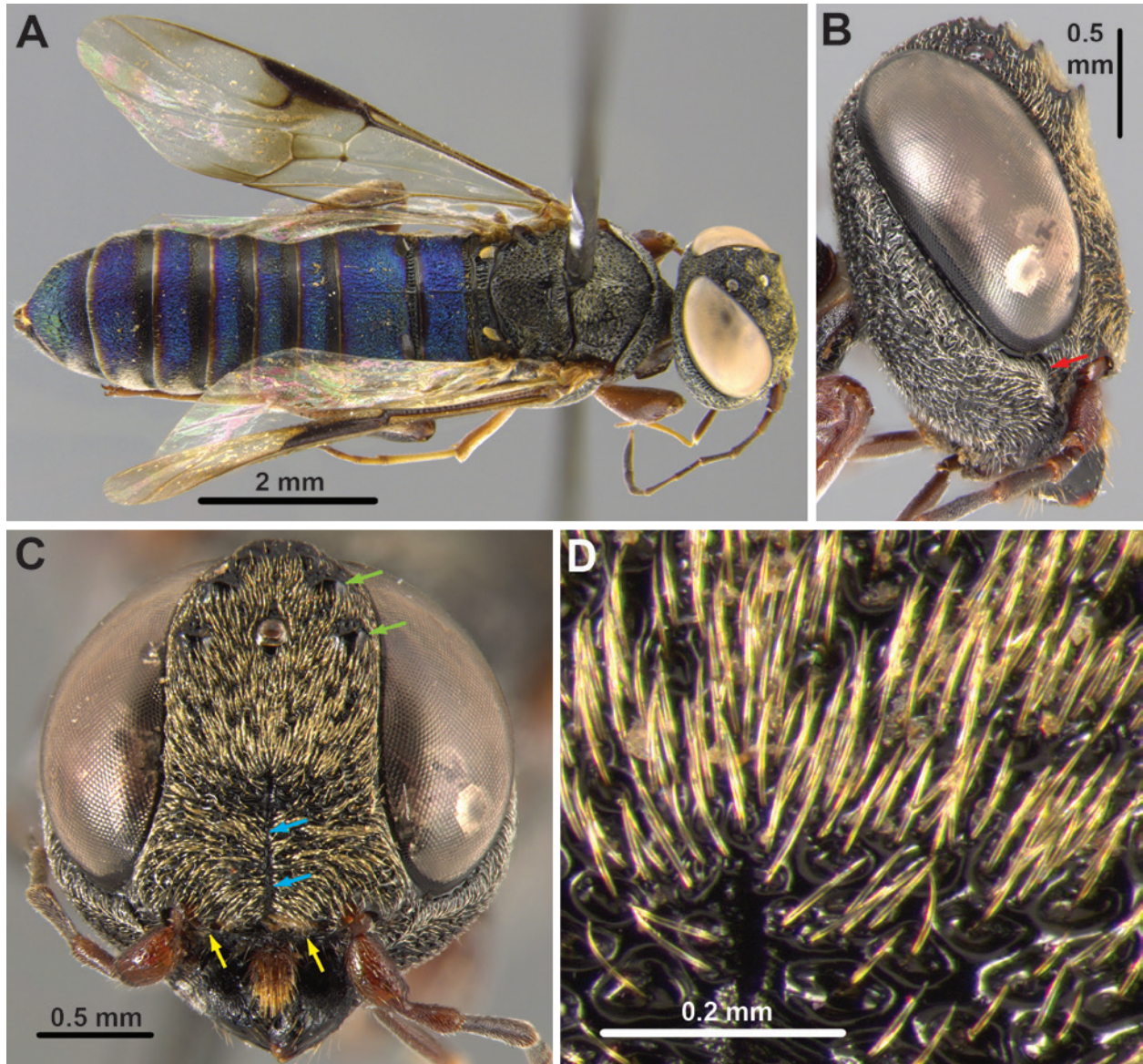


Fig. 2. *Orussobaius nielspederi* n.sp., holotype, DEI-GISHym 18582, ♀ (OLML). **A:** Habitus, dorsal (after cleaning with acetone). **B:** Head, lateral. **C:** Head, anterior. **D:** Frontal setae. — **Arrows:** Red arrow = malar groove; green arrows = coronal teeth; blue arrows = dorsoventral frontal furrow; yellow arrows = ventral transverse frontal carina.

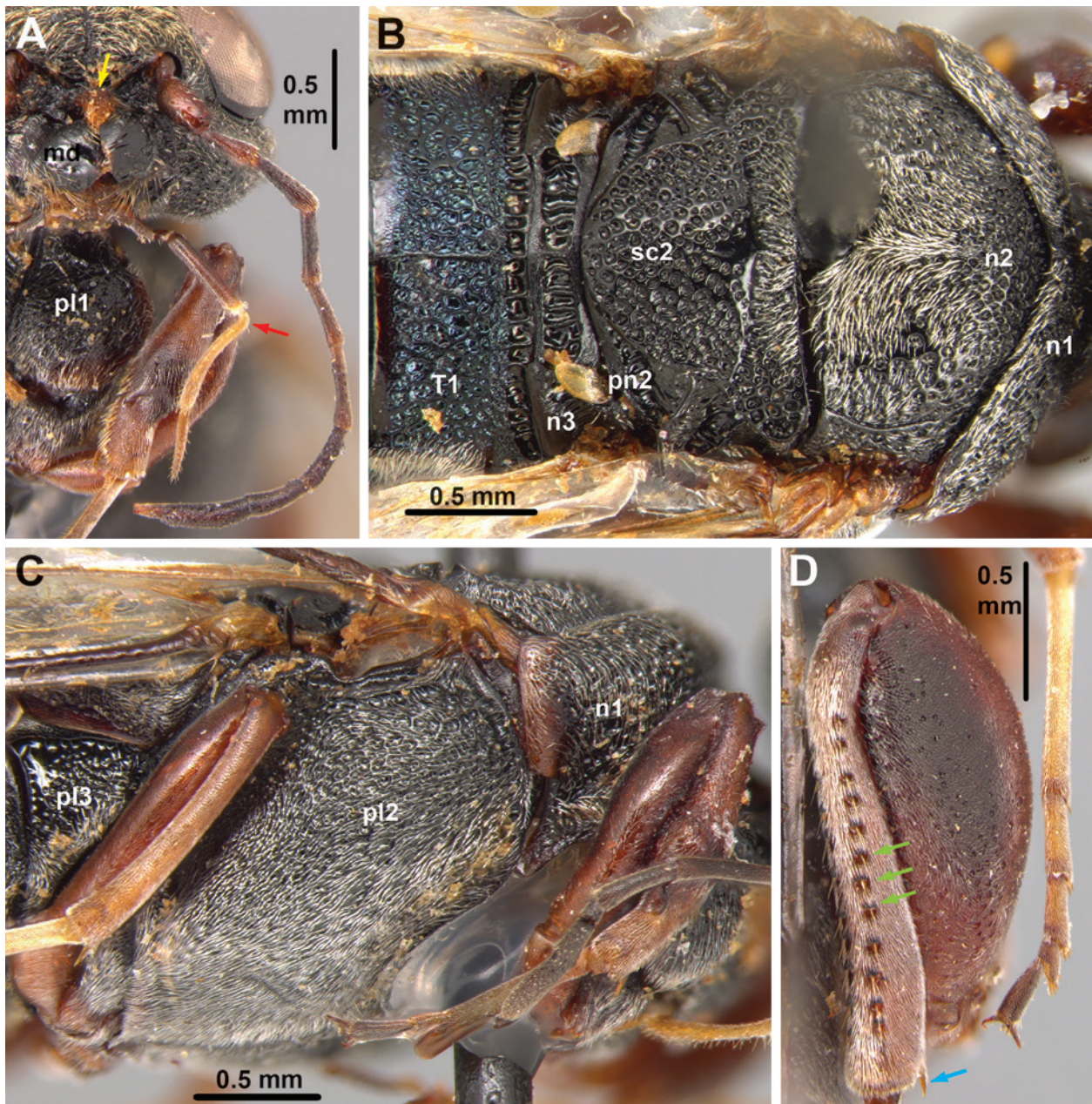


Fig. 3. *Orussobaius nielspederi* n.sp., holotype, DEI-GISHym 18582, ♀ (OLML). **A:** Antenna and mouthparts, ventral. **B:** Thorax, dorsal (prior to cleaning with acetone). **C:** Thorax, lateral. **D:** Hind femur and tibia. — **Abbreviations and arrows:** md = mandible; n1 = pronotum; n2 = mesoscutum; n3 = metanotum; pl1 = propleuron; pl2 = mesopleuron; pl3 = metapleuron; pn2 = mesopostnotum; sc2 = mesoscutellum; T1 = tergum 1; red arrow = maxillary palp; yellow arrow = labrum; green arrows = dorsal pegs on hind tibia; blue arrow = hind tibial apical spur.

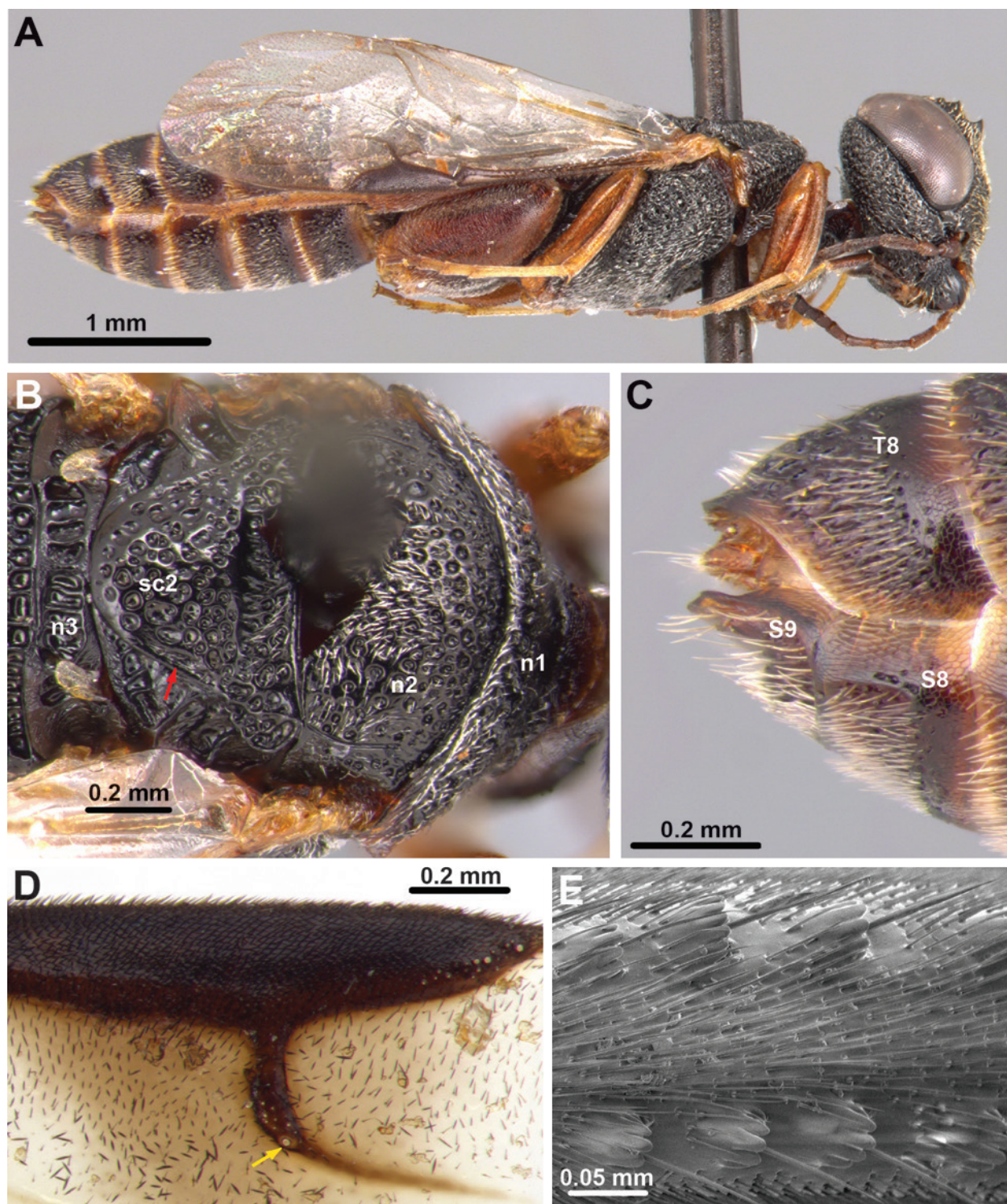


Fig. 4. *Orussobaius nielspederi* n.sp. **A–C:** Paratype, DEI-GISHym 18587, ♂ (OLML). **A:** Habitus, lateral. **B:** Thorax, dorsal. **C:** Posterior abdomen, lateral. **D:** Holotype, DEI-GISHym 18582, ♀ (OLML). Pterostigma and 2r-rs in forewing. **E:** Paratype, DEI-GISHym 18585, ♀ (DEI). Dorsal pegs on hind tibia (distal to the right). — **Abbreviations and arrows:** n1 = pronotum; n2 = mesoscutum; n3 = metanotum; S8 = sternum 8; S9 = sternum 9; sc2 = mesoscutellum; T8 = tergum 8; red arrow = groove laterally on mesoscutellum; yellow arrow = large dome-shaped sensillum in 2r-rs.

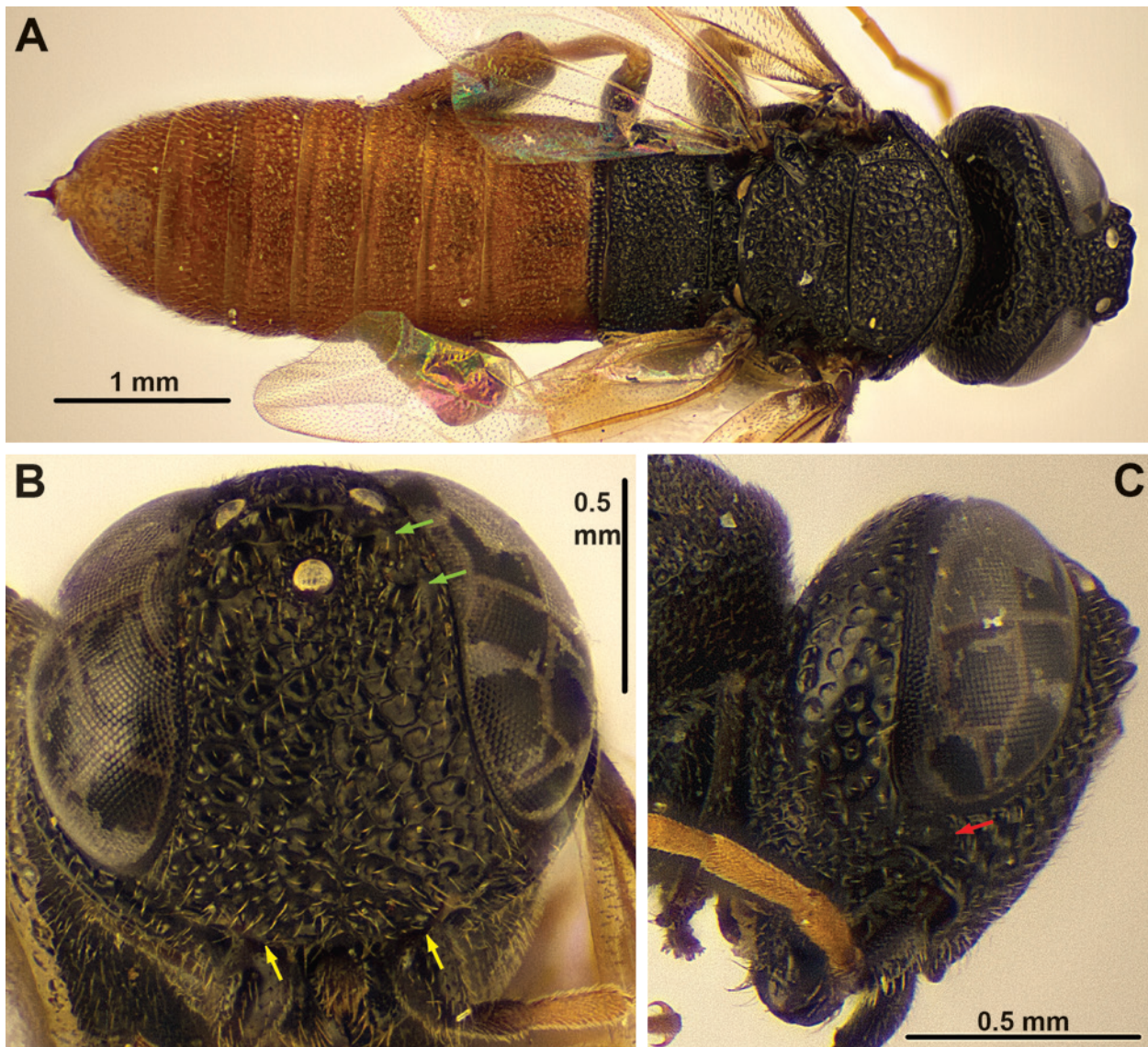
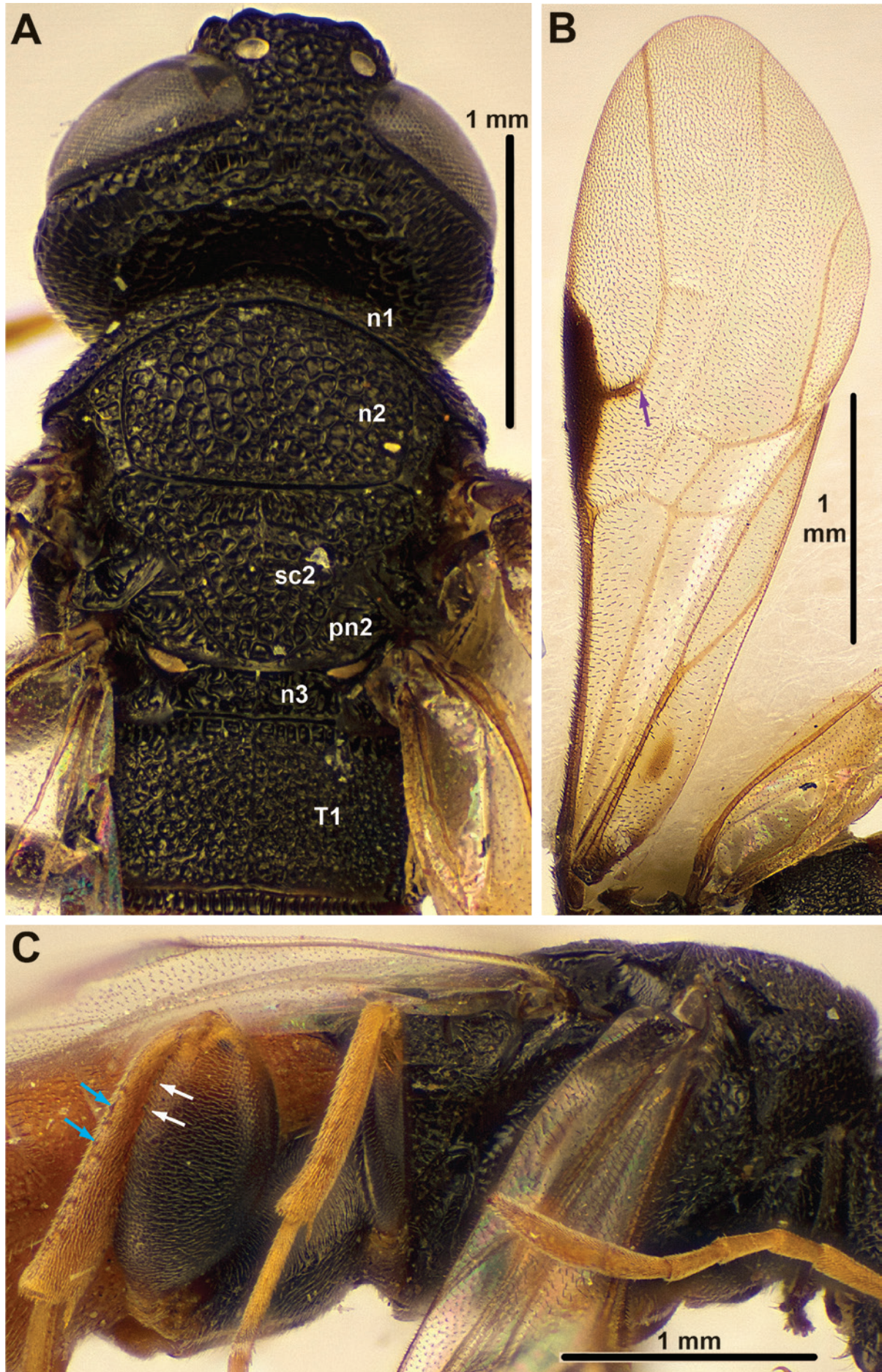


Fig. 5. *Orussobaius bicolor* n.sp., holotype, ♀ (QMBA). **A:** Habitus, dorsal. **B:** Head, anterior. **C:** Head, lateral. — **Arrows:** red arrow = malar depression; green arrows = coronal teeth; yellow arrows = ventral transverse frontal carina.

→ **Fig. 6.** *Orussobaius bicolor* n.sp., holotype, ♀ (QMBA). **A:** Head and thorax, dorsal. **B:** Forewing. **C:** Thorax, lateral. — **Abbreviations and arrows:** abbreviations as in Fig. 2; violet arrow = large sensilla in 2r-rs; white arrows = denticles on hind femur; blue arrows = pegs on hind tibia.



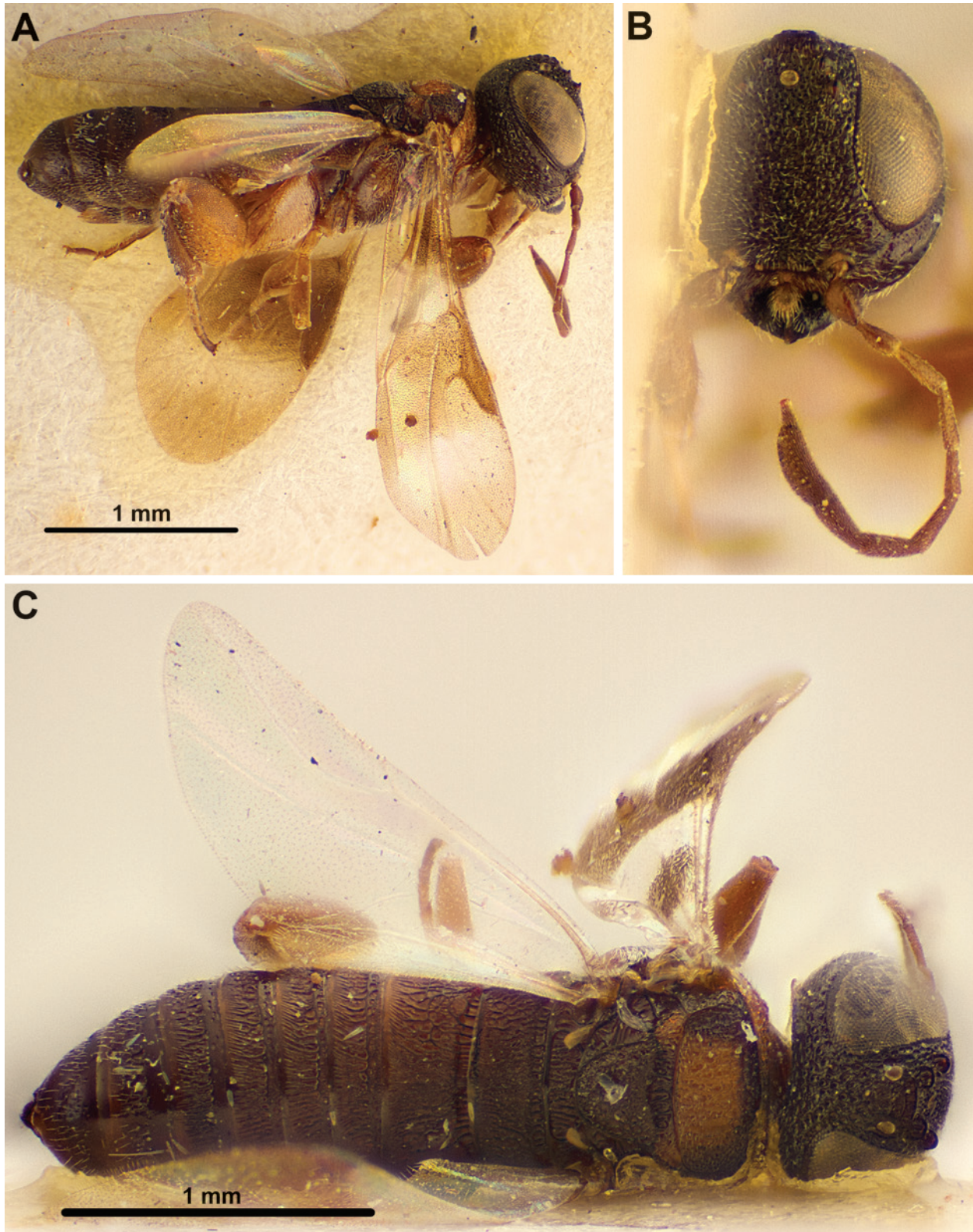


Fig. 7. *Orussobaius badius* Schmidt & Vilhelmsen, 2002, holotype, ♀ (QMBA). **A:** Habitus, lateral. **B:** Head, anterior. **C:** Habitus, dorsal.

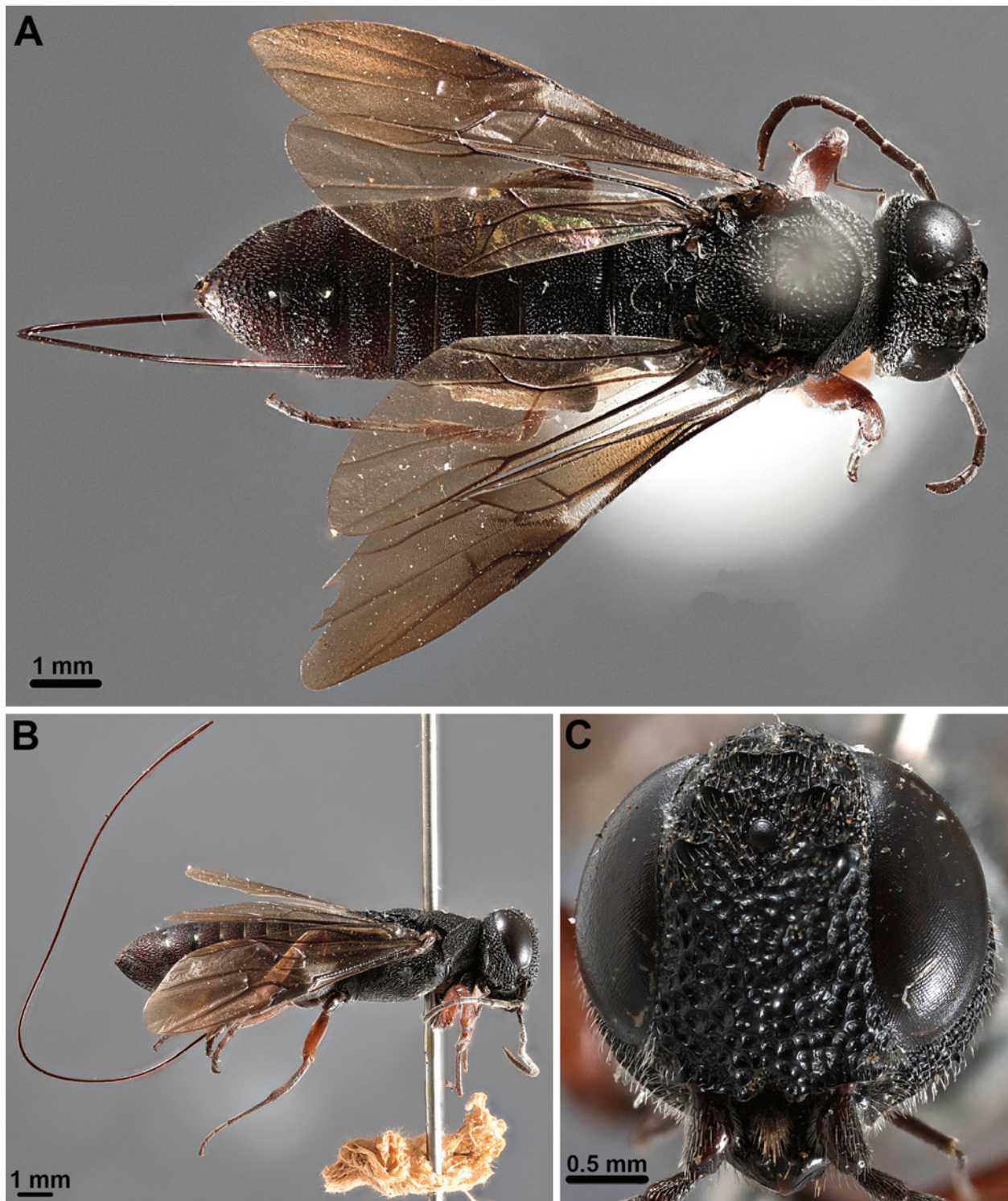


Fig. 8. *Orussobaius caligneus* Schmidt & Vilhelmsen, 2002, holotype, ♀ (WAMP). **A:** Habitus, dorsal. **B:** Habitus, lateral. **C:** Head, anterior.

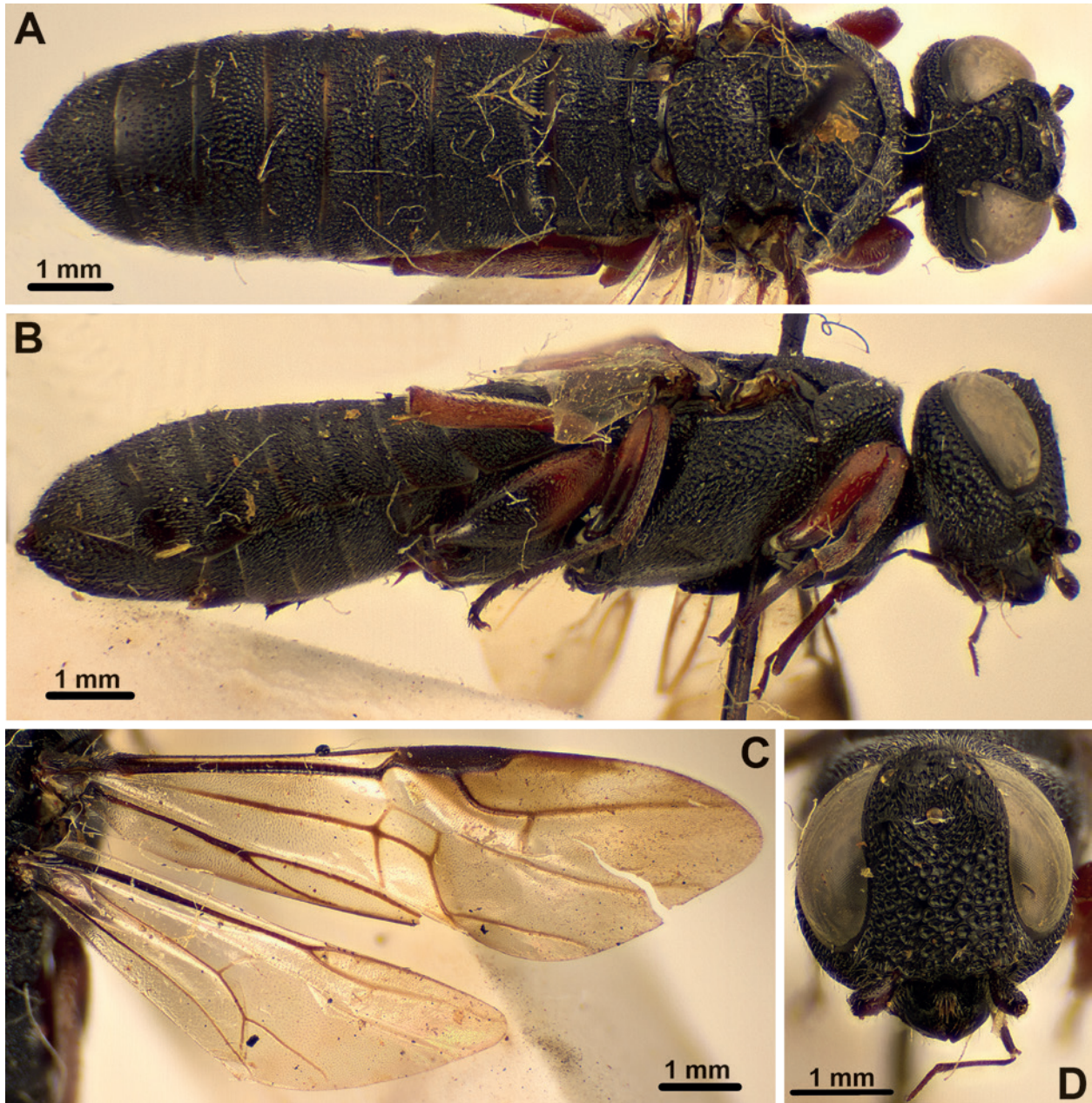


Fig. 9. *Orussobaius mesembrinus* Benson, 1938, holotype, ♀ (MV). A: Habitus, dorsal. B: Habitus, lateral. C: Wings. D: Head, anterior.

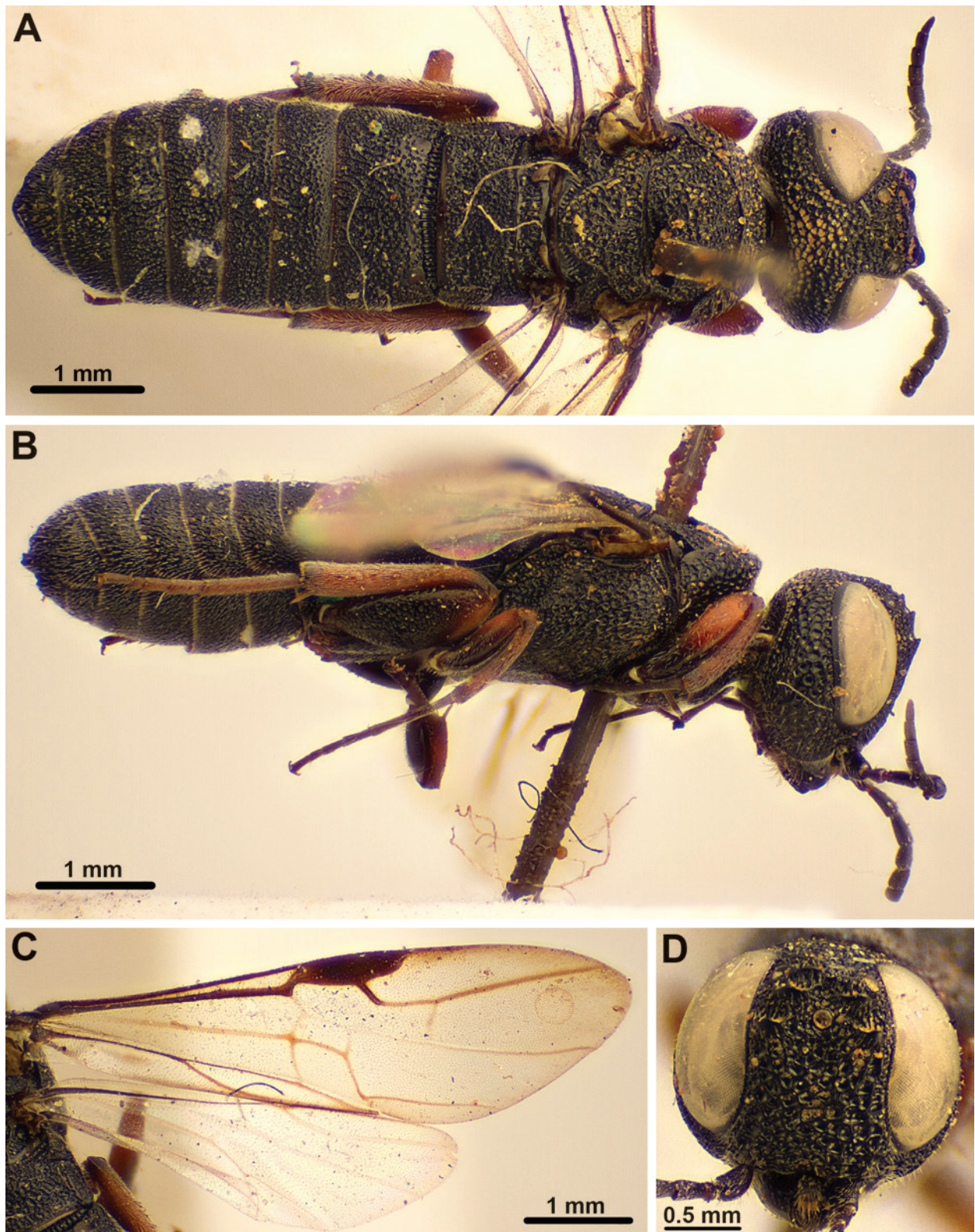


Fig. 10. *Orussobaius mesembrinus* Benson, 1938, allotype, ♂ (MV). **A:** Habitus, dorsal. **B:** Habitus, lateral. **C:** Wings. **D:** Head, anterior.

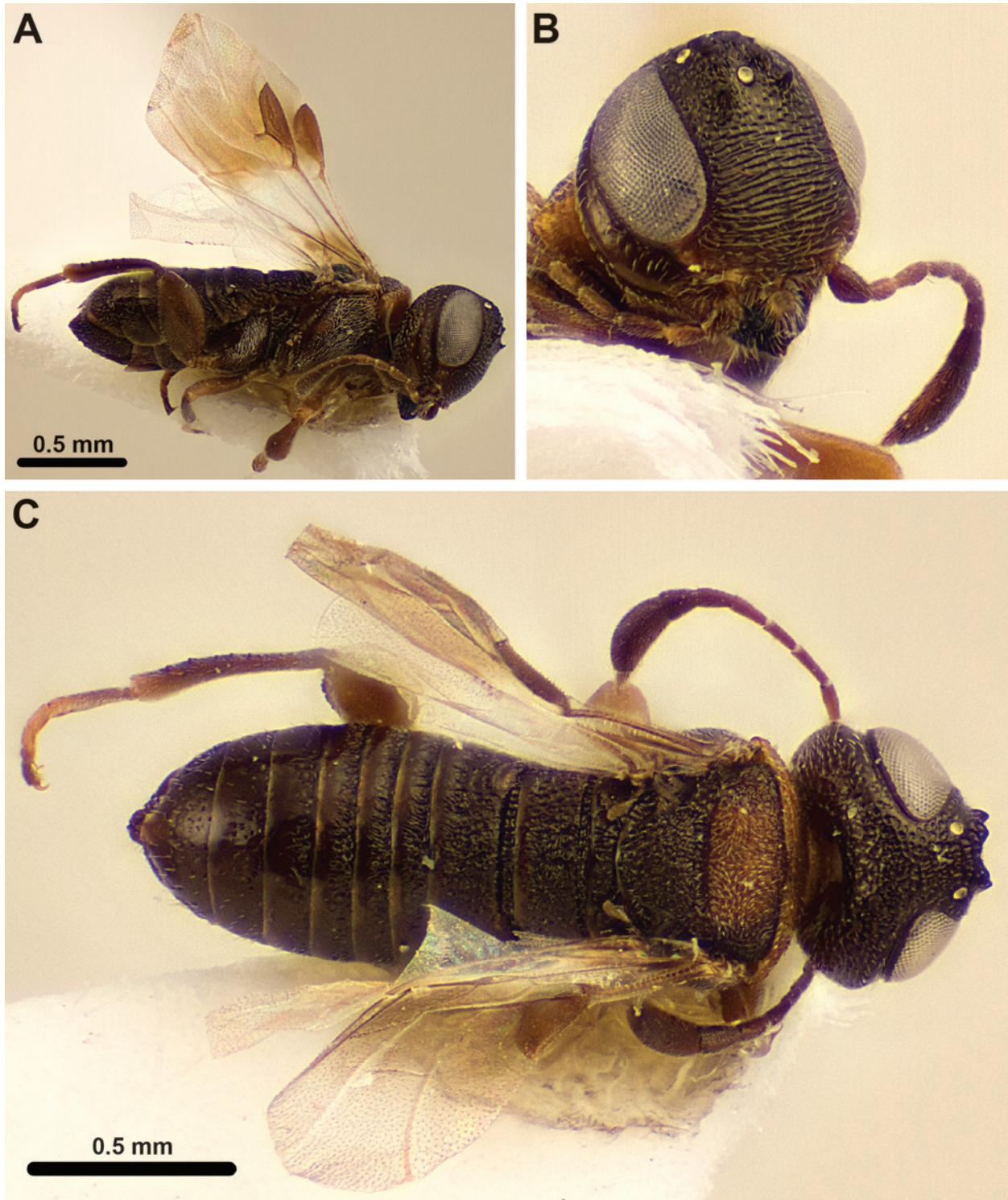


Fig. 11. *Orussobaius minutissimus* Schmidt & Vilhelmsen, 2002, holotype, ♀ (ANIC). **A:** Habitus, lateral. **B:** Head, anterior. **C:** Habitus, dorsal.



Fig. 12. *Orussobaius minutus* Benson, 1938, allotype, ♂ (QMBA). **A:** Habitus, dorsal. **B:** Habitus, lateral. **C:** Head, anterior.

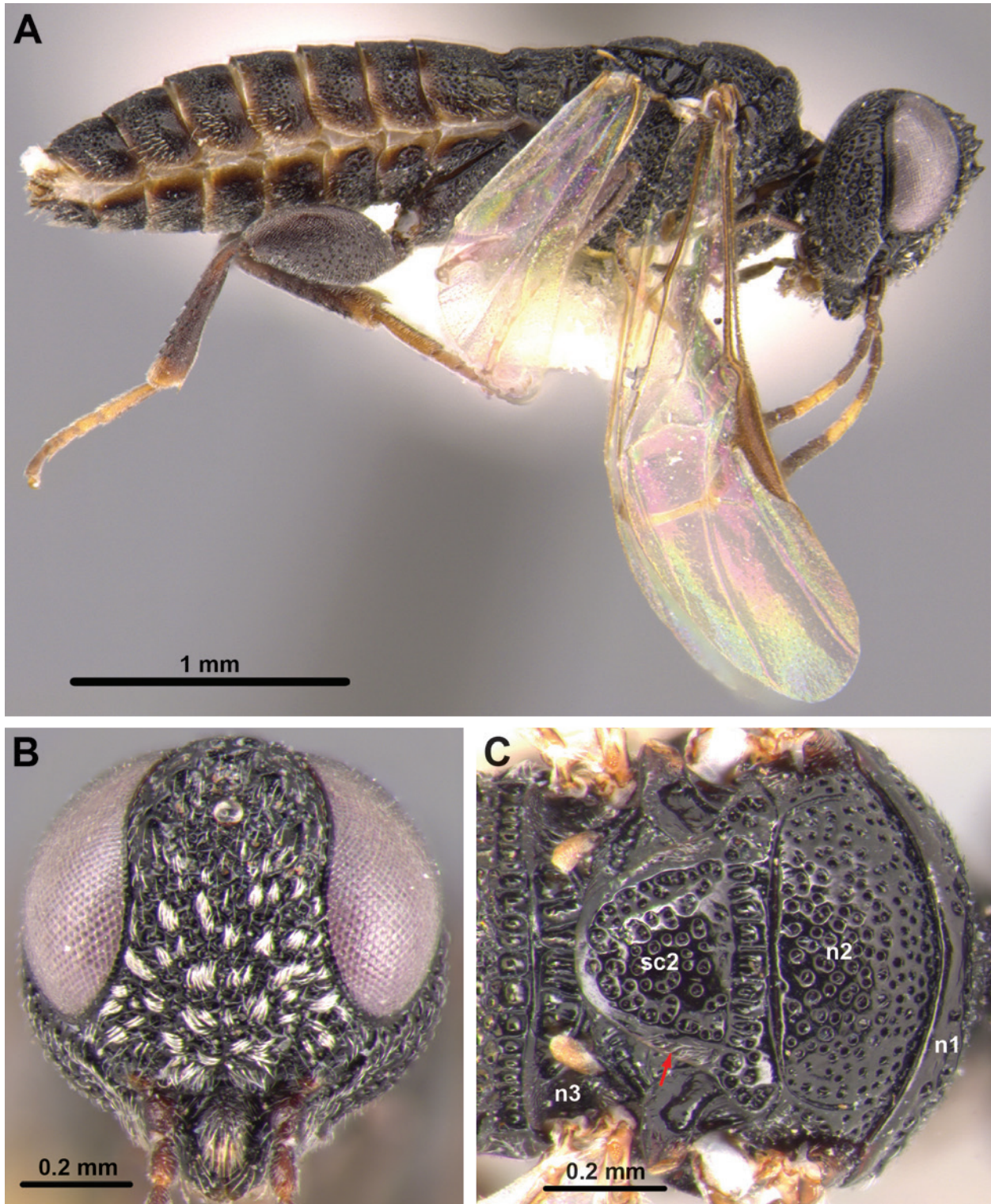


Fig. 13. *Orussobaius paniculus* Schmidt & Vilhelmsen, 2002, holotype, ♂ (ANIC). **A:** Habitus, lateral. **B:** Head, anterior. **C:** Thorax, dorsal. — **Abbreviations** and **arrows:** n1 = pronotum; n2 = mesoscutum; n3 = metanotum; sc2 = mesoscutellum; red arrow = groove laterally on mesoscutellum.

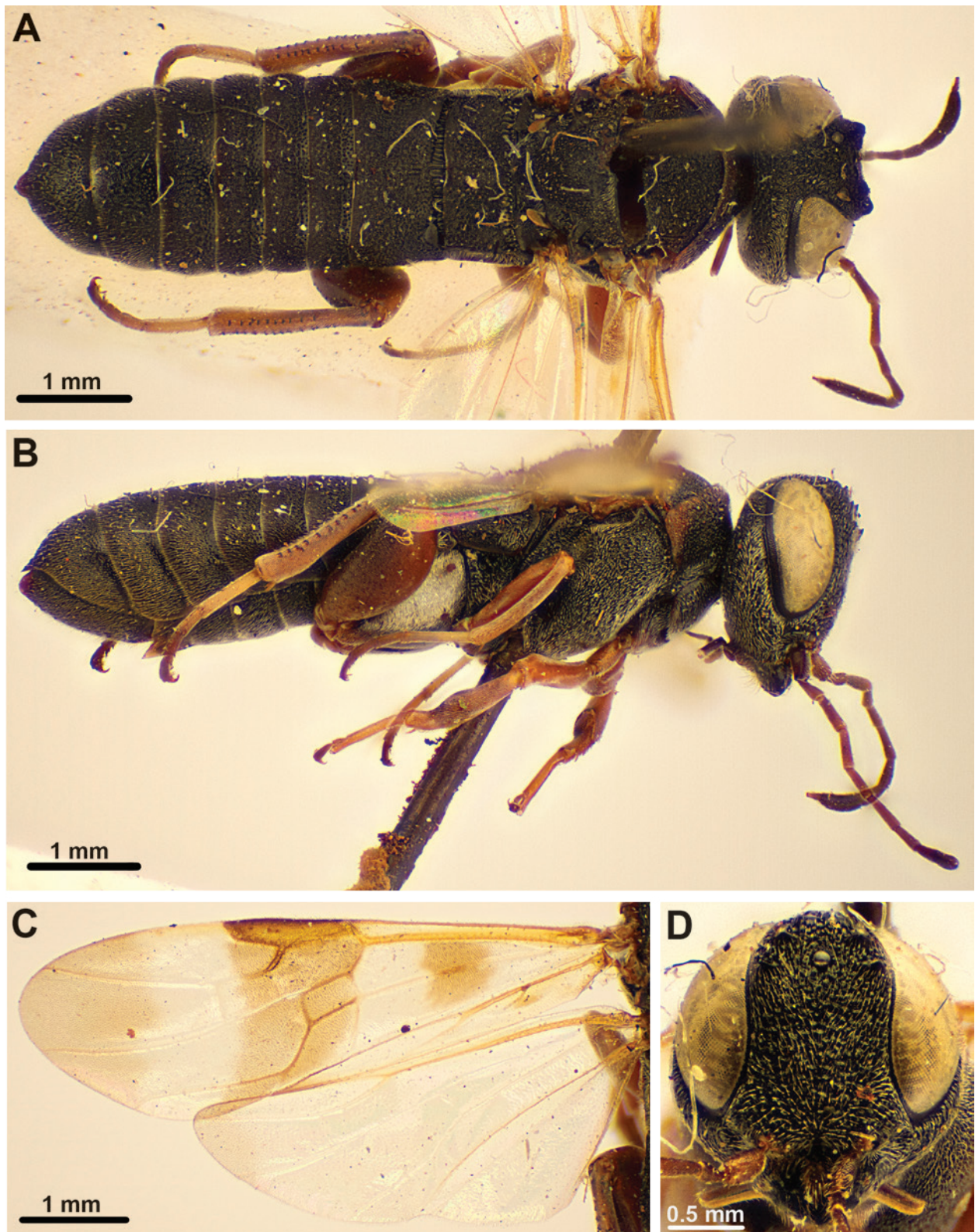


Fig. 14. *Orussobaius wilsoni* Benson, 1938, holotype, ♀ (MV). A: Habitus, dorsal. B: Habitus, lateral. C: Wings. D: Head, anterior.

